A Nomadic Information System for Adaptive Exhibition Guidance

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Abstract

The paper describes the electronic guide HIPS that can be used all along the process of a visit in a museum, i.e., for preparation, execution and evaluation. Users can access the system via the Web to prepare a visit by receiving information about the content and organization of an exhibition and practical issues like location and opening hours. The visitor can also prepare a tour for the actual visit or define hotspots with important exhibits the system should remind the user when being on site. Once the user is in the museum he or she has two specific options to use the system: The visitor can walk around in the museum and remain standing where he or she finds an item of interest. The current location in the room identified by infrared emitters at all exhibits triggers an indicator for the information presentation. Or, the visitor can select a tour prepared by a curator, prepared by the user in advance (at home) or generated by the user ad hoc. In the museum, the information access is provided via wireless technologies. This allows the user to access information by moving in the physical space and navigating in the information space concurrently. The Web-based server approach allows for adaptive information selection and presentation based on a user model evaluating the history of the usage of the system. The user can accelerate the adaptation by specifying interests and preferences in the user model. Before the visit the user can define tours and hotspots and enter annotations that will be presented or activated by the system in the appropriate physical environment. After a visit in the museum the user can evaluate the experience at home for further own inquiries or for communication with other interested people. The before-during-after-the-visit-support of visitors via nomadic information system has been designed based on evidence from our questionnaire pre-study, which showed that visitors actually use information available in or about museums also before and after a visit.

1. Introduction

The paper describes the goal and practice of the nomadic guide Hippie[1] that can be used all along the process of a visit in a museum, i.e., for the preparation, the visit itself and its evaluation. An information system is said to be nomadic when the user has access to his or her personal information space from all places independent from specific devices. To understand cultural heritage both is necessary, information about the background or the context of an event or exhibition as a whole and information about the details of single units (exhibits) and the experience of the authentic environment. The first aspect, the holistic view, can most probably best be studied before and after the visit. The details can probably best be studied in front of an exhibition combining the authentic sensory perception with additional information provided by a complementary medium. The main purpose of the electronic guide presented in this paper is to support the actual visit of a museum, i.e., to enrich the understanding and enjoyment of exhibits, not to replace a real visit by a virtual visit. The electronic guide provides the information access at home via normal Internet connection for the preparation and evaluation of a visit and inside the museum information access is provided via wireless technologies. The latter allows the user to access information by moving in the physical space and navigating in the information space concurrently. A Web-based client-server approach allows for adaptive selection and presentation of information based on a user model evaluating the history of the usage of HIPS with respect to knowledge, interests and preferences. The user can accelerate and modify the adaptation by specifying interests and preferences in the user model.

2. Information for visitors of cultural exhibitions

Even if information giving is not a museum's only goal the information profits of museum visitors is often modest. People are restricted in their information selection and perception not only by their individual time but also by available information and presentation media. For visitor studies in mu-

Media	Media used during the current visit	Media preferred for a normal visit
Maps, navigation, signs	28%	46%
Catalogue, guidebook	30%	40%
Tourist guide	11%	24%
Leaflets	9%	14%
Audio guide	4%	15%
Information desk	6%	13%
Comments of friends	20%	17%
Going autonomously (without information media)	40%	34%

Table 1

seums see Bourdieu, Darbel, Schnapper (1991), Hooper-Greenhill (1995). In a questionnaire study in 6 art museums in Europe with 561 visitors involved we found a preference of people to get and use more information media then currently available on site. About 10% of the visitors preferred to get more information than currently available.

Not only information during a visit but also information about the museum exhibition before and after a visit is appreciated by the visitors. More than two third of the respondents report that "sometimes", "often" or "always" they use information media *before* they visit a museum; almost two third reported the same for *after* the visit.

Even if the absolute numbers of these results are possibly biased due to social desirability of the answers the tendency shows that visitors want to know what they can see in a museum to make up their mind for an actual visit decision and to prepare or evaluate a visit.

The numbers show that people like more information about artworks in museum environments. This is remarkable from the background that people are socialized in their information behavior by the few information resources available in and about culture and art exhibitions. The results do not show the potential for new products and services; 10% of visitors liking more information is not overwhelming. People extrapolate their experience from temporary offers. The real potential can best be tested by prototypes and pre-products in a mid-term period of time when new ways of information and communication media are offered and used and new styles of behavior are established.

Currently visitors of environments of cultural relevance, i.e., an event, a building, an artwork, typically read information labels attached to the exhibits, leaflets available in individual rooms or brochures offered at the information desk. Visitors also listen to guides, both human guides and recently also more and more audio guides or they use kiosk systems. More extensive material like a textbook or a catalogue is bought only by a small subset of visitors. Such books are more suitable to be used (or simply to be exposed in a showcase) at home. Reading a textbook or viewing a book of plates can be seen as a virtual visit of a cultural environment. The media can explain exhibits or events by pictorial reproductions, texts or videos. A virtual visit allows for reading more detailed information about the given exhibition or more exhaustive explanations of a collection of exhibits. Studying explanations of cultural heritage away from the real place does not provide access to the atmosphere of the environment and can not support the understanding of the context or the real life experience of an exhibition.

Both real and virtual visits show their pros and cons. A real visit is time limited, the place is sometimes crowded, hot or cold, not stimulating for extensive reading and discussing. On the other hand a real visit gives an authentic impression of the exhibition, the atmosphere, and the context.

Information Used	never	seldom	sometimes	often	always
before a visit	6%	19%	35%	31%	10%
after a visit	8%	26%	38%	19%	2%

Table 2

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A virtual visit provides less chance to immerse into the environment of the exhibits; motivation and concentration may be less intensive. It can, on the other side, be organized for the best suitable time and location, supported by explanatory information including texts, pictures, sound and video, and it can be repeated and combined with other exhibitions or exhibits displayed at different places all over the world.

The benefits of both a real visit and a virtual visit can be combined with new media that augment the real experience with additional information supporting a richer understanding and enjoyment of cultural heritage. Two aspects are important for a combination, first, the interconnection of the authentic environment with more extensive and flexible information access and, second, the continuous support of the process of reception by the same media from the preparation of a visit to the evaluation and communication of results.

3. Information system for a continuous visiting process

Hippie as an internet-based guide offers added value to current information facilities by supporting all along the process of the perception of cultural heritage. The process supporting information is made possible by the nomadic characteristic of the system that allows the user to have access to his or her personal information space from all places independently from specific devices (for nomadic systems in general see Kleinrock 1997). The information selected and presented to the visitor reflects the location (at home or in front of an exhibit), the interests, the knowledge and the presentation preferences of the user. Dynamic elements for animated interpretation and auditive modality complement the visual modality preoccupied by the physical environment. The user is equipped with a handheld computer and a headphone to listen explanations of the current object and environment to immerse into the subject of interest. The user is left alone with the physical environment and the complementary explanations; via the communication function of the system he or she can also get in touch with other individuals present in the real or virtual exhibition for appointments or for communicating suggestions.

In the following we describe the main features of the system to explain the benefit for the users: the process support by permanent system accessibility, the location awareness of the system to present information suitable to the current position of the visitor, multimodal information presentation to exploit the range of human perception, and the information adaptation to the user's knowledge and interests. Additionally some features are described that increase the practical value of the system.

3.1. Internet connectivity for continuous information with different devices

Internet connectivity provides access to the information basis from all over the world. At home the user can access the system with a desktop computer with high resolution representations to study the site of interest, e.g., a content list and pictures of an exhibition, descriptions of individual artworks and artists as well as practical information about opening hours, ticket prices etc., and to prepare an actual visit. The visit in the exhibition is supported by a handheld computer (PDA) with wireless LAN connection[2]. Access points provide the network connection within the museum. Being in the museum the user can receive the same information space he or she is already familiar with from sessions at home. The same richness of information is available even the visitor will not see a high resolution representation. On a small screen only a thumbnail icon will be presented to reassure the visitor that the information that is presented is about the artwork he or she is in front of. Not the device follows the user but the information access is ubiquitous.

3.2. Location awareness

The user of the nomadic system is free to move around in the physical space. The system identifies the current position of the user in two ways. It knows about the type of computer and the environment the user is connected to. At home a big computer with high resolution and high bandwidth is used. In the museum a small computer with a small screen and lower bandwidth requires an adaptation of information presentation: less explicit interaction, more implicit interaction by navigation in the physical space, more audio presentation than text, less detailed graphical presentations and more thumbnails.

The second type of location awareness means the current coordinates of the visitor within the museum. By infrared infrastructure the position and by an electronic compass the direction of the visitor is identified and transmitted from the handheld computer to the server so that the server can automatically send the appropriate information for the visitor about the current exhibit. The infrared infrastructure consists of emitters being installed on the walls underneath each exhibit. The emit-

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ters send an ID to a receiver being fastened on the jacket of the visitor or attached to the user's headphones and connected to the handheld computer. Additional emitters are installed above each door of the museum allowing the identification of the visitor passing the entrance of a room before entering into the cone of an exhibit emitter. By this means a continuous localization of the visitor can be used for the information selection and be displayed on a map of the museum if the visitor requires support for the navigation in the physical space, e.g., to find an exhibit of interest.

If a new item of potential interest is detected by the infrared component the system presents an "earcon" combined with a blinking "News" icon on the screen that can be clicked by the user. Then the system displays one or more names and thumbnail presentations of the current exhibits[3]; with a follow up hyperlink the user can start the presentation. A sequence of the "News" notification, the display of close paintings to be selected and the interesting presentation of the third option "Armour and Merkur" is shown in figure 1.

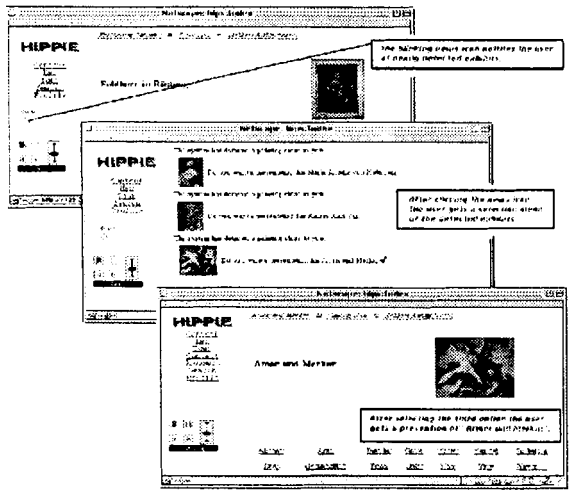

Figure 1: Notification of a new exhibit next to the wandering visitor

3.3. Multimodal information presentation

The information presentation for visitors during the preparation and evaluation phases is unimodal containing pictures and text. This type of presentation reflects the typical interaction and perception style of a user at a desktop and enables easy reading and printing including scanning and browsing the information space. The information presentation during the visit is multimodal containing written text on the screen and spoken language via headphones and multicodal including text, graphics and animations. The visitor's visual attention is free for the physical environment, especially for the exhibits. Most information is presented without requiring a look of the visitor on the screen. The audio information to be presented is currently composed by snippets of canned texts spoken by a human being. Later also computer-generated language can be used, once it is of sufficient quality. At present generated language can at mostly be used for direction giving information: "Turn left", "In front of you ...". At present 819 audio objects are included in the system. For the paintings between 160 and 300 sec of presentations of 7 to 25 attributes are offered with an average time of 207 sec. For all artworks, including sculptures and art crafts, an average time of 90 sec is offered.

There are some cases when a look of the visitor on the screen is necessary. The first is the navigation support that goes beyond a simple direction giving hint, e.g., go right, turn left and the like. An orientation in the physical space and the location of oneself and of exhibitions of interes may require a graphical map with identifiers for the visitor and for the exhibitions. The second case where visitors may need screen displays are visual aids to understand an artwork, e.g., the composition, the form design or the color design. The electronic guide provides explanations of such features of artworks not only by textual descriptions but also by graphical illustrations and videos. Figure 2 shows an example of a graphical form design explanation and explaining text displayed right to the graphical illustration (the text is also presented auditively via headphones).

3.4. Information adaptation to user's knowledge and interests

As described above the information selection and presentation is adapted to the currently used device, to the network connection, and to the location of the user. Now we will describe the adaptation of the information selection and presentation to the individual user (for user adaptation see Kobsa, Nill, Fink 1997; Oppermann 1994). The user can be more or less competent of and interested in the domain in question. The adaptive component runs a user model describing the knowledge and the interests of the user. The user model automatically evaluates the user's interaction with the system in the information space and the user's navigation in the museum, i.e., in the physical space. Externally acquired knowledge is not accessible to the system; interests can only be evaluated based on the interaction of the user with the

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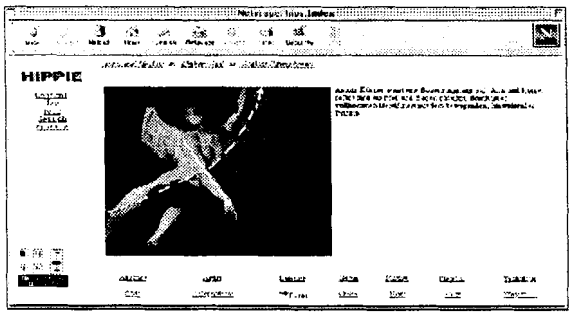

Figure 2: Form design description by graphical teaching lines with written and spoken text

system; alternatively the system allows the user to specify prominent interests in a user profile dialogue.

If the user has used the system to select information about an exhibition, an artist, an artwork, particular attributes of an artwork and so on, the system updates the user model for seen entities and seen topics. For the following presentations it can adapt the information to the user's assumed pre-knowledge and interests. The adaptation to the assumed pre-knowledge is performed by avoiding redundancy (see also Not et al. 1997). A painting that has already been seen by the user and explained to him or her by its name, author, dateline and style will only be reassured by its name when the user selects it a second time; more information are offered of course for explicit requests of the user.

The adaptation to the assumed interests of the user is provided by adaptive tips. If a user selects a number of exhibits the user model identifies common attributes of the selection in terms of, e.g., artist, style or genre. In case of exceeding a rule-defined threshold the system initiates a "Tip" displayed by a three times blinking light on the screen that can be clicked by the user. The system presents an observation as a list of objects the user has selected, e.g., paintings from the genre "mythology", and a recommendation of a tour the user can start encompassing other paintings of the genre "mythology" to be seen in the museum. Two screenshots with a blinking light notifying the user of available tour proposals and a cumulation of three tours with the system's observations and inferred tour proposals are shown in figure 3.

The same rule-based mechanism is applied for the presentation of attributes of the artworks. If the user selects a set of particular interesting attributes for the user the system recommends to present the set of attributes as a default sequence of topics for the given class of artworks. The user who is more interested in the history and social background gets a sequence of topics like biography and period, the user who is more interested in art analytical topics gets a sequence of composition and form and color design.

By adaptations of the information selection and presentation the benefit of a visit for the user is expected to be higher, especially the knowledge and understanding of the exhibition in general and the exhibits in particular but also the richness of experience can be intensified by personalised information.

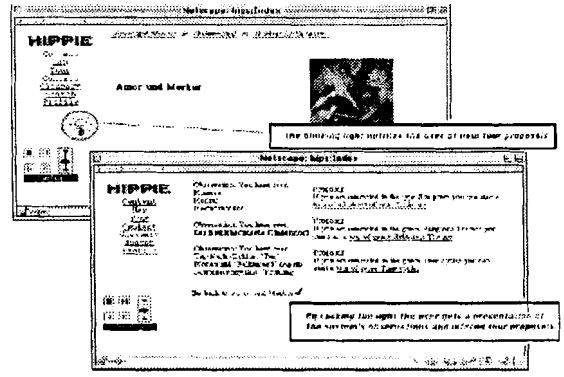

Figure 3: Notification of an adaptive tour proposal

3.5. Annotation, explanation and communication

Hippie provides additional features to support the individual user and a user group. For the process of a visit at different times and places it is helpful for the user to make notes attached to exhibitions or to individual artworks in order to store personal explanations or bookmarks available during a visit. An annotation button "notes" attached to the presentation of the exhibits supports this goal.

The "contact" function of the system allows the user to communicate with other users. The communication can be directed to a dedicated addressee (a partner, a family, a group). A list of currently present users is offered as well as the possibility to enter a full e-mail address to contact a remote user. Recommendations can be exchanged while moving independently through the physical space or simply appointments can be made to meet in the cafeteria in half an hour. Messages can also be directed to the public as a contribution to a growing knowledge base about the environment.

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For definitions of terms and descriptions of names a "glossary" is available that can be addressed as a function via the main menu and in the context of content description on the fly via hyperlinks.

By the combination of features described above Hippie makes use of Weiser's vision, called calm technology by ubiquitous computing (Weiser 1991). The equipment used in the museum and the information and communication interface is designed to let the visitor walk in the physical space of the museum getting access to a contextualised information space tailored to the individual needs and the current environment. Contextualised information presentation takes into account more than just the user's location (for contextualisation see Schmidt, Beigl, Gellersen 1998; Brézillon 1998; Abowd et al. 1997). A contextualised information space is defined by an information repository adapted to the location, the user and the task. In the case of a museum visit as an instance of self defined activities the task can be replaced by the visitors interest.

4. Evaluation

The added value of the system compared with current information media has got positive feedback from experts from computer science and cultural heritage domain (museum curators, art educators). During the development of the system formative evaluations have been conducted with human factor experts and an art educator. The input has been used to improve the content and the user interface of the system. The current issue of evaluation is the dynamic of the meta-dialogue between the system and the user for the location aware presentation and for adaptation proposals. There is a goal conflict between the full control of the dialogue to the user and a short and easy confirmation of system initiated proposals. In case of the location aware presentation of a new item of potential interest a sound icon (earcon) is presented combined with a blinking "News" icon on the screen that can be clicked by the user. The system presents the exhibit the user is in front of and the user can start the presentation. Sound (earcon), blinking "News" icon, and exhibits are presented and have to be perceived and controlled by the user. In case of the adaptive tour proposal a blinking "Tip" icon, observation(s) of seen objects and proposal(s) of suggested tour(s) have to be perceived and controlled by the user. At least for the mobile scenario we are looking for simpler ways of a meta-dialogue that reduces the dialogue steps but keeps the user in control.

Summative evaluations of the system have been performed with domain experts, i.e., artists, art educators, and museum curators during a one-day demonstration and feedback workshop. The experts confirmed the added value of the nomadic information system both for the process support of preparing, conducting, and evaluating a museum visit and for the understanding of the artworks with respect to the wide spectrum of information provided by the system. The participants pointed out that the user-system

interaction of a mobile guide has to be designed for specific requirements of the exhibition domain. On the one hand, for technical exhibitions a mix of automatic offers and active requests of information might have a stimulating effect. On the other hand, in art exhibitions, perceiving art might be limited by a conflict between promenading an exhibition and searching information. The permanent offer of structured information might obstruct the visitor to get involved in a silent conversation with an artwork and to develop an individual understanding. Providing personalised views and individual tours was appreciated. Especially personalised information for visitor interests and knowledge was considered important. Adaptive information selection reduces redundancy and information overload. The overall feedback was very positive expecting that new media guides increase the attraction of museums.

Evaluations with real users are planned. Results with ecological validity can only be gained in mid term experiments where users have the opportunity to develop new habits of information behavior with enriched but easy to use information media. Individual cases of visitors supported by the electronic guide showed that users with extensive interest and pre-knowledge in art immersed into the perception of the exhibits on the wall and the information presented by the system; they exploited the richness of the information space both quantitatively with a average presentation time of 2.5 min. per exhibit and qualitatively with audio and text presentation and additional graphical support for the art analytical understanding of aspects like composition, form or color design. Visitors with only curiosity and low pre-knowledge used the system for short snippets of information while wandering through the exhibition. Whether the average visitor can be stimulated to perceive a more intensive presentation and develop a more extensive understanding of artworks will be investigated in mid or long term studies.

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Notes

1. The prototype Hippie was developed by GMD within the project Hyperinteraction within Physical spaces (HIPS), an EU-supported LTR project in ESPRIT I³. The partners of the consortium are University of Siena (co-ordinating partner), University of Edinburgh, University College Dublin, ITC, SINTEF and GMD, CB&J, and Alcatel.

2. Currently no PDA is available with a PCMCIA slot for the wireless and for infrared receiver (see next paragraph). Therefore at present we use a Toshiba Libretto 100 CT. Suitable PDAs are announced for the near future.

3. In case of small exhibits or exhibits one above the other an infrared emitter is connected to several exhibits so that having clicked the "News" button the user receives a list of items.

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